Abstract Submitted
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Understanding the unsteady aerodynamics of a revolving wing with pitching-flapping perturbations[1] LONG CHEN, JIANGHAO WU, CHAO ZHOU, Beihang University, SHIH-JUNG HSU, Pennsylvania State University, University Park, AZAR ESLAM PANAH, Pennsylvania State University, Berks, BO CHENG, Pennsylvania State University, University Park — Revolving wings become less efficient for lift generation at low Reynolds numbers. Unlike flying insects using reciprocating revolving wings to exploit unsteady mechanisms for lift enhancement, an alternative that introduces unsteadiness through vertical flapping perturbation, is studied via experiments and simulations. Substantial drag reduction, linearly dependent on Strouhal number, is observed for a flapping-perturbed revolving wing at zero angle of attack (AoA), which can be explained by changes in the effective angle of attack and formation of reverse Karman vortex streets. When the AoA increases, flapping perturbations improve the maximum lift coefficient attainable by the revolving wing, with minor increases of drag or even minor drag reductions depending on Strouhal number and normalized flapping amplitude. When the pitching perturbations are further introduced, more substantial drag reduction and lift enhancement can be achieved in zero and positive AoAs, respectively. As the flapping-perturbed wings are less efficient compared with revolving wings in terms of power loading, the pitching-flapping perturbations can achieve a higher power loading at 20° AoA and thus have potential applications in micro air vehicle designs.

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